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THE RELATION OF TWO BI-FACTORS TO ACHIEVEMENT IN GEOMETRY AND OTHER SUBJECTS

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A great deal of research has been done on the isolation of factors in the domain of psychological abilities and on the use of factors as tools of scientific description in this field. Very little has been done, however, in the use of factorial abilities as predictive measures of scholastic success. The present study was undertaken to discover the predictive value of the spatial and general deductive factors in forecasting the achievement of high-school students in plane geometry. The general and spatial factors were employed because preliminary research indicated that they would be more effective for this purpose than factors such as verbal ability, memory, speed, and others.

Most of the tests in the battery to be described were specially devised at our laboratory with particular emphasis on improving the measure of the spatial factor determined in other studies.[1] The factor tests were given in the autumn to students of plane geometry in the Thornton Township High School of Harvey,

[1] Karl J. Holzinger and Frances Swineford, *A Study in Factor Analysis: The Stability of a Bi-factor Solution.* Supplementary Educational Monographs, No. 48. Chicago: Department of Education, University of Chicago, 1939.

Frances Swineford and Karl J. Holzinger, *A Study in Factor Analysis: The Reliability of Bi-factors and Their Relation to Other Measures.* Supplementary Educational Monographs, No. 53. Chicago: Department of Education, University of Chicago, 1942.

Illinois, through the kind permission of Dr. Clifford R. Maddox, Supervisor of Instruction. We are also especially indebted to Mr. Guy Phillips, head of the Mathematics Department, who assisted in carrying out the extensive testing program.

The test battery includes eight spatial tests and three additional tests which were necessary in order that the spatial factor might be separated from, and studied independently of, the general factor. The three latter tests are Series Completion, Woody-McCall Mixed Fundamentals, and Word Classification.

Previous studies have consistently indicated tests of the number-series type to be excellent measures of the general factor. The present such instrument consists of forty series of five numbers each, followed by three blanks to be completed by the subject. The Woody-McCall Test is a standardized arithmetic test. The Word Classification items are lists of five words of which one is a misfit and is to be underlined. Experience with these three tests indicates that their intercorrelation is due entirely to the general factor.

All the spatial tests except Cubes and Figures were devised for the present study. Visual Imagery is presented in verbal form, but requires ability to visualize objects. For example, the subject is asked to imagine a block of wood of given dimensions, painted on certain faces. He may then be asked how many small cubes (dimensions given) can be cut from the block, how many of these cubes will have paint on one face, two faces, etc. Four series of questions of this general nature are included.

The two Punched Holes tests were patterned after a similar test used by Dr. L. L. Thurstone, and revised with his permission. The verbal form asks the subject to imagine a square sheet of paper folded twice in a designated manner, and a hole, or holes, punched in certain places. He is then to indicate where the holes will appear when the paper is unfolded. The non-verbal form of the test is similar to the verbal form, except that the folding is indicated in drawings instead of verbally.

The Cubes test consists of pictures of pairs of cubes. There is a design on each face of each cube, but only three faces are visible in the drawing. The subject must determine whether the two pictures could represent the same cube in different positions or must represent different cubes, under the assumption that no design appears twice on one cube.

Figures is one of Dr. Thurstone's tests, used with his permission. In each item a simple geometrical figure is presented, followed by a row of six drawings of the same figure rotated into different positions. Some mirror images of the figures are also included. The subject is required to check all drawings which are not mirror images.

Each item of Form Relations is a black square except for an irregularly shaped section which is missing. Below is a series of ten black shapes, one of which will complete the square.

In Pattern Perception a group of dots which form a pattern is given. To its right is a larger group of dots. The subject is to find the given group within the larger group and draw a line around it. There is only one possible answer to each such item.

Drawings consists of a set of geometrical figures. The subject is to draw mirror images of these figures.

With the exception of Figures (see note to Table 1), the score on each of the tests is the number of items answered correctly. The time limits are generous, so that the resulting scores are in no sense speed scores (again excepting Figures).

Table 1 presents data relating to the length and timing of the tests, as well as the means and standard deviations obtained for the present group. The total administration time amounts to three hours, ten minutes, and the total testing time is two hours, twenty-six minutes, which is seventy-seven per cent of the administration time.

The subjects consist of one hundred eighty-three pupils in five plane geometry classes, which were taught by four different teachers. Nine pupils were omitted from the group on which the test intercorrelations are based, because they were absent on one or more of the testing days. Of the one hundred seventy-four cases which remain, about fifty per cent were juniors (Grade 11), a few were seniors, and the remainder, sophomores, as shown in Table 2. There were almost twice as many boys as girls.

The intercorrelations of the battery of factor tests are presented in Table 3, the test numbers being identified from the stub in Table 1. The average correlation for the whole table is .418, which is relatively high for a battery of tests of factorial abilities.

A bi-factor analysis of the correlations was made to verify the test groupings found in previous studies and to furnish the necessary statistics for estimation of the two orthogonal factors: gen-

TABLE 1.—TEST DATA

Test	Number of Items	Time in Minutes		Mean	Standard Deviation
		Total	Testing		
1 Series Completion.....	40	20	16	25.4	8.5
2 Woody-McCall Mixed Fundamentals.....	35	22	20	28.3	3.3
3 Word Classification.....	61	12	10	32.6	5.4
4 Visual Imagery.....	36	20	18	19.9	8.3
5 Punched Holes—Verbal	18	25	20	11.4	4.5
6 Punched Holes.....	20	17	12	15.2	4.3
7 Cubes.....	40	15	8	27.2	7.0
8 Figures.....	54*	15	5	30.5	12.1
9 Form Relations.....	25	12	10	18.9	4.1
10 Pattern Perception.....	30	18	15	20.4	5.8
11 Drawings.....	24	14	12	16.8	5.9

* There are fifty-four correct drawings among the twenty items. The score is R − W. Omitted items are counted neither right nor wrong.

TABLE 2.—CLASSIFICATION OF PUPILS

Year in School	Boys	Girls	Total
Seniors.....	5	8	13
Juniors.....	62	27	89
Sophomores.....	44	25	69
Not known.....	2	1	3
Total.....	113	61	174

eral ability and spatial ability. The factor pattern, with three small 'doublets' omitted, is shown in Table 4. It is obvious that the Series Completion test is by far the best measure of the general factor. The Visual Imagery test, the Punched Holes tests, and the Drawings test appear as the best measures of the spatial factor, but the other factor weights for the spatial factor are also substantial.

TABLE 3.—INTERCORRELATIONS OF ELEVEN TESTS
N = 174

Test	1	2	3	4	5	6	7	8	9	10	11
1											
2	.421										
3	.285	.256									
4	.521	.166	.227								
5	.434	.209	.177	.599							
6	.518	.263	.226	.647	.802						
7	.328	.092	.097	.475	.459	.443					
8	.412	.178	.194	.499	.515	.583	.486				
9	.333	.177	.173	.563	.470	.575	.438	.540			
10	.400	.237	.265	.542	.561	.657	.394	.443	.619		
11	.415	.242	.218	.636	.653	.747	.475	.501	.566	.633	

TABLE 4.—FACTOR PATTERN
(Doublets and unique factors omitted)

Test	Factors	
	General	Spatial
1 Series Completion	.857	....
2 Woody-McCall Mixed Fundamentals	.473	....
3 Word Classification	.416	....
4 Visual Imagery	.502	.592
5 Punched Holes—Verbal	.461	.625
6 Punched Holes	.570	.654
7 Cubes	.272	.509
8 Figures	.442	.455
9 Form Relations	.391	.552
10 Pattern Perception	.523	.508
11 Drawings	.503	.673

The residual correlations, obtained by means of the original coefficients of Table 3 and the reproduced correlations from the complete form of Table 4, are negligible with a standard deviation of only .0343.

About nine months after the factor test battery was administered an achievement test was given at the end of the school year.

The test was the American Council Coöperative Plane Geometry Test, Revised Series, Forms R and S. The content of this test closely paralleled the course of study in plane geometry throughout the year and was considered a fair and objective measure of achievement in geometry for the academic year.

Space does not permit the inclusion of all our multiple correlation analysis, but the multiple correlations themselves are of considerable interest. The multiple correlation for the general factor and its best estimate from the entire battery is .903; the corresponding coefficient for the spatial factor is .897. It is therefore apparent that the battery as a whole provides excellent measures of these two factors. The correlation between the standardized geometry test and the best estimate of such ability from the entire factor test battery (involving both factors) is .768. This last multiple correlation indicates that our battery of eleven tests of general and spatial ability have a remarkably high predictive value for success in plane geometry. It is rare indeed that any predictive measure of scholastic success given at the beginning of a school year will correlate nearly .8 with an achievement measure at the end of that year. This finding appears the more striking when it is noted that the correlation between a local geometry test given at the end of ten weeks had a correlation of only .690 with the American Council year-end geometry test.

TABLE 5.—CORRELATIONS BETWEEN GROUPS OF FACTOR TESTS AND FINAL GEOMETRY TEST

Factor Tests in Battery	Total Testing Time	Multiple R for Predicting Final Test	Correlation of Sum of Raw Test Scores with Final Test
All eleven.....	190	.768	....
1, 4, 6.....	57	.700	.699
1, 4, 5.....	65	.713	.711
1, 3, 4, 5.....	77	.741	.739

In order to study the adequacy of shortened batteries of factor tests for predicting geometrical ability, multiple correlations and correlations from sums of raw scores were obtained as shown in Table 5. From this table it is apparent that factor tests 1, 4, and

5 (Series Completion, Visual Imagery, and Punched Holes—Verbal) can be administered in a little over an hour and have a predictive value of .713 for plane geometry as measured by the American Council test. The local geometry test given at the end of ten weeks had a lower multiple correlation (.690) as already indicated.

The correlations in the last column of Table 5 indicate that, as is so often the case, a simple sum of raw scores furnishes nearly as good a prediction as the sum of predicting variables weighted with regression coefficients. In the present case at any rate the practical schoolman would merely need to administer tests 1, 4, and 5, or possibly tests 1, 3, 4, and 5; add the raw test scores from either of these sets; and still obtain at the beginning of the school year better predictive measures of success in plane geometry than was afforded by the ten-week teacher-made geometry test.

Although this study was designed to investigate the relation of the general and spatial abilities to success in plane geometry, data for other school subjects were also obtained with a view to seeking additional use of factor estimates. Letter-grades for thirty or more pupils in each of eight subjects, including geometry, have been correlated with regression estimates of the pupils' factor scores. These correlations are given in Table 6, together with

TABLE 6.—CORRELATIONS OF SCHOOL MARKS WITH IQ, G, AND S

School Subject	IQ		G		S	
	N	*r*	N	*r*	N	*r*
Plane Geometry	158	.381	172	.584	172	.227
English	155	.484	169	.422	169	.002
Biology	56	.550	59	.586	59	−.003
Foreign language	92	.487	94	.523	94	−.057
Chemistry	64	.268	70	.386	70	.257
History	38	.286	41	.374	41	.237
Shops and crafts	32	−.081	40	.219	40	.461
Drawing	26	.035	30	.412	30	.692
IQ	...	.....	162	.652	162	.092

correlations with IQ, based on the Henmon-Nelson Test of Mental Ability, Form A, which is given to all pupils who enter the freshman class of the Thornton Township High School.

In presenting these data, we do not intend to imply that the present battery should be adequate to predict success in all the school subjects listed. The verbal factor, which has not been considered here, is important in connection with English, foreign languages, history, and possibly other subjects as well. The purpose of this part of the study, then, is merely to point out the relation of the two factors under consideration and the several school subjects as measured by teacher's marks, and to compare these factors with IQ as predictors.

Except in the case of English, it will be observed that G is a better predictor of scholastic success than is IQ; it is a much better predictor for plane geometry. In the case of shops and crafts and drawing the predictive value of the IQ is worthless, while the predictive value of G is only fair as indicated by the coefficients of .22 and .41.

The correlations of school marks with the spatial factor S are very small except for these last two subjects. It is reasonable that spatial ability should be related to skill in shop work and drawing, and the coefficients of .46 and .69 are high enough to warrant much further study with more objective measures of scholastic achievement than marks.

The number of cases involved in some of the groups is too small for any safe generalization, but it is interesting to observe that while spatial ability correlates with geometry as measured by teachers' marks only to the extent of .23, its correlation with shop work is .46 and with drawing, .69. Our hypothesis at the beginning of this study was that a long battery of spatial tests should yield a factor S highly predictive of plane geometry. The correlations of Table 6 indicate that the general factor is a much better predictor of geometry than is the orthogonal space factor. For shop work and drawing, the predictive value of these two factors appears to be reversed. Our original hypothesis is thus not confirmed by these correlations, and an alternate hypothesis for future research would appear to be that the space factor is highly predictive of applied skills such as those demanded in shop work and drawing rather than the somewhat limited theoretical applications in plane geometry.

It will be observed that we have studied the predictive value of the orthogonal factors G and S in the present paper. These factors are orthogonal merely because we chose them that way. The obvious advantage of employing orthogonal rather than oblique factors is that their relations with other variables may be studied independently. If one desired to employ an oblique 'spatial' factor it would be measured in our study by a pool of tests 4 to 11, and, from Table 4, it would obviously be a combination of our orthogonal factors G and S. Such a spatial factor, although statistically and psychologically acceptable, would not provide the kind of experimental evidence cited above that was desired in the latter part of this study.

CHILDREN'S CHOICES OF FAVORITE BOOKS: A STUDY CONDUCTED IN TEN ELEMENTARY SCHOOLS*

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METHOD AND PROCEDURES

Most graded bibliographies of juvenile literature have been made according to adult criteria of the worth and suitability of certain volumes. Another basis for the selection of books may be found in the choices of the boys and girls themselves. To ascertain which books are favorites with pupils, questions were presented to 7,879 school children from kindergarten through Grade VIII in the spring of 1945. These pupils were enrolled in six Chicago public schools in neighborhoods of poor, good and excellent socio-economic levels. Four other schools located in three smaller cities were also included; in these schools the children come from comfortable and superior homes. With one exception, the schools have central libraries. However, in this school, each classroom contains a small library.

In the kindergarten and in the first three grades, the children were asked to name the stories they liked best. Their homeroom teachers wrote down the pupils' responses and reported them as homeroom choices. A questionnaire filled in by the children in grades IV through VIII provided spaces for the boys and girls to list the five books they had read and most enjoyed during the year 1944–45.

TABLES OF CHILDREN'S BOOK FAVORITES

Tables I, II, III, and IV present the favorite titles in the kindergarten; in grades I, II, and III; in grades IV, V, and VI; and in grades VII and VIII. These books are ranked according

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to frequency of mention. In the kindergarten there were fourteen titles which were cited as classroom choices from two to seven times; in the primary grades there were forty-six titles which were also cited as classroom choices from three to nineteen times. There are fifty book titles in each of the two remaining lists; each title received citation from eighteen to one hundred ninety-five pupils.

TABLE I.—BOOK FAVORITES—KINDERGARTEN

Author and title	Rank	Author and title	Rank
Simon and Schuster *Little Golden Book of Fairy Tales*	1.0	Flack *Ask Mr. Bear*	10.5
Flack *Angus and the Ducks*	2.0	Flack *Story About Ping*	10.5
Bannerman *Little Black Sambo*	4.5	Friskey *Seven Diving Ducks*	10.5
Gruelle *Raggedy Ann*	4.5	Huber *I Know a Story*	10.5
Lindman *Snipp, Snapp, Snurr* Books	4.5	Lowrey *Poky Little Puppy*	10.5
Potter *Tale of Peter Rabbit*	4.5	Wehr animated edition of *Hansel and Gretel*	10.5
		Bishop *Five Chinese Brothers*	10.5
		Flack *Restless Robin*	10.5

COMPARISON OF CHILDREN'S BOOK FAVORITES WITH STANDARD BIBLIOGRAPHIES

In examining these lists one should bear in mind that the titles are the unrestricted choices of children who regularly attend movies, listen to the radio, and read comic books and strips in their leisure time. Thus, we approach the present bibliography with the respect due books that have withstood the competition of the strong appeals of these popular activities.

There were 4,343 different titles mentioned ranging in 'goodness' from the *Bobbsey Twins* and the *Dave Dawson* stories to established classics and modern books of excellence such as the Caldecott and the Newbery Awards.*

* The John Newbery Medal is awarded by the children's librarians of America to the author of each year's "most distinguished contribution to American literature for children." The medal was established in 1922. The Caldecott Medal is awarded by the same group of librarians to the illustrator of each year's "most distinguished picture book for children." This medal was established in 1938.

TABLE II.—BOOK FAVORITES OF THE PRIMARY-GRADE CHILDREN (GRADES I–III)

Author and title	Rank
Disney version of *Bambi*	2.0
Bannerman *Little Black Sambo*	2.0
McCloskey *Make Way for Ducklings*	2.0
Lang *Cinderella*	4.0
Disney *version of Pinocchio*	5.0
Anderson *Billy and Blaze*	6.5
Austin *Peter Church-mouse*	6.5
Gag *Snippy and Snappy*	8.0
Piper *The Little Engine that Could*	9.5
Barnett *They Hunted High and Low*	9.5
Disney *Donald Duck and His Nephews*	12.0
Huber *It Happened One Day*	12.0
Grimm *Fairy Tales*	12.0
Brown *Polite Penguin*	14.5
Gruelle *Eddie Elephant*	14.5
Bishop *The Five Chinese Brothers*	18.0
Fairy Tales (no edition mentioned)	18.0
Disney-Palmer *Mickey Never Fails*	18.0
Wehr animated edition of *Little Red Riding Hood*	18.0
Brooks *To and Again*	18.0
Cameron *Three Bears*	25.5
Huber *I Know a Story*	25.5
Washburne *Little Elephant Stories*	25.5
Friskey *Wings Over the Woodshed*	25.5
Disney-Emerson *School Days in Disneyville*	25.5
Garis *Uncle Wiggily* Books	25.5
Beim *Lucky Pierre*	25.5
Potter *Tale of Peter Rabbit*	25.5
Wehr animated edition of *Puss in Boots*	25.5
Whiteford *How Sandy Squirrel Got His Tail*	25.5
Travers *Mary Poppins* Books	34.0
Friskey *Scuttlebutt Goes to War*	34.0
Wells *Peppi the Duck*	34.0
Payne *Katy No Pocket*	34.0
Hope *Bobbsey Twins*	34.0
McCloskey *Homer Price*	34.0
Craik *Little Lame Prince*	34.0
Andersen *Fairy Tales*	42.0
Ferris *"Watch Me," Said the Jeep*	42.0
Flack *Story About Ping*	42.0
Friskey *Seven Diving Ducks*	42.0
Leaf *Ferdinand*	42.0
Molnar *Blue-Eyed Lady*	42.0
Credle *Down Down the Mountain*	42.0
Credle *Little Jeems Henry*	42.0
Evers *Cry Baby Calf*	42.0

TABLE III.—BOOK FAVORITES OF THE INTERMEDIATE GRADES (IV–VI)

Author and title	Rank
Knight *Lassie Come Home*	1.0
Atwater *Mr. Popper's Penguins*	2.0
Sewell *Black Beauty*	3.0
Clemens *Adventures of Tom Sawyer*	4.0
Fairy Stories (no edition given)	5.0
Rains *Lazy Liza Lizard*	6.0
McCloskey *Homer Price*	7.0
Grimm *Fairy Tales*	8.0
Estes *The Moffat Books*	9.0
Brooks *Freddy the Detective*	10.0
Geisel *The Five Hundred Hats of Bartholomew Cubbins*	11.5
O'Brien *Silver Chief*	11.5
Lofting *Dr. Doolittle* Books	13.0
Arabian Nights Entertainment	14.0
Spyri *Heidi*	15.0
Disney version of *Pinocchio*	16.5
Sture-Vasa *My Friend Flicka*	16.5
Flack *Walter the Lazy Mouse*	18.0
Travers *Mary Poppins* Books	19.0
Pyle *Merry Adventures of Robin Hood*	20.0
Gramatky *Little Toot*	22.0
McSwigan *Snow Treasure*	22.0
Wolo *Amanda*	22.0
Clemens *Adventures of Huckleberry Finn*	25.0
Salten *Bambi*	25.0
Seredy *The Good Master*	25.0
Bontemps *The Fast Sooner Hound*	27.5
Disney *Life of Donald Duck*	27.5
Jones *Twig*	30.5
Anderson *Blaze and the Gypsies*	30.5
Defoe *Robinson Crusoe*	30.5
Wells *Peppi the Duck*	30.5
Disney *Mickey Mouse Movie Stories*	33.0
Bishop *Five Chinese Brothers*	35.0
Dogdson *Alice in Wonderland*	35.0
Brink *Caddie Woodlawn*	35.0
Craik *Little Lame Prince*	38.0
Lang *Cinderella*	38.0
White *Mouse Knees*	38.0
Lindman *Snipp, Snapp, Snurr* Books	40.0
Disney *version of Bambi*	42.0
Lattimore *Little Pear*	42.0
Petersham Products Series	42.0
Disney-Ayer *Donald Duck and His Friends*	44.0
Aulaire *Abraham Lincoln*	45.0
Enright *The Saturdays*	46.0
Estes *The Hundred Dresses*	47.5
Henry *The Little Fellow*	47.5
Kaler *Toby Tyler*	49.5
Thurber *Many Moons*	49.5

TABLE IV.—BOOK FAVORITES—UPPER GRADES (VII—VIII)

Author and title	Rank
Knight *Lassie Come Home*	1.0
Estes *Moffat* Books	2.0
Boylston *Sue Barton* Books	3.0
Tunis *Keystone Kids*	4.0
O'Brien *Silver Chief*	5.0
Terhune *Lad*	6.0
Tunis *All American*	7.0
Brink *Caddie Woodlawn*	8.0
Sperry *Call It Courage*	9.0
Stevenson *Treasure Island*	10.0
Sewell *Black Beauty*	11.0
Tunis *Kid from Tomkinsville*	12.0
Forbes *Johnny Tremain*	13.0
Clemens *Adventures of Tom Sawyer*	14.5
Seredy *The Good Master*	14.5
Beals *Davy Crockett*	17.0
Sture-Vasa *My Friend Flicka*	17.0
Tunis *Champions' Choice*	17.0
Tunis *Yea Wildcats*	19.0
All the Alcott Books	21.5
Jones *Twig*	21.5
Meader *Shadow in the Pines*	21.5
Tunis *World Series*	21.5
Meader *Sea Snake*	24.0
Spyri *Heidi*	25.0
Grimm *Fairy Tales*	26.5
Seredy *A Tree for Peter*	26.5
Alcott *Little Women*	28.5
Pyle *Merry Adventures of Robin Hood*	28.5
Burnett *Secret Garden*	32.0
Arabian Nights Entertainment	32.0
Defoe *Robinson Crusoe*	32.0
Seymour *On the Edge of the Fiord*	32.0
Worth *They Loved to Laugh*	32.0
Baker *Mystery at Four Chimneys*	35.0
Davis *Stand Fast and Reply*	37.0
Salten *Bambi*	37.0
Smith *A Tree Grows in Brooklyn*	37.0
Atwater *Mr. Popper's Penguins*	39.5
White *They Were Expendable*	39.5
Disney-Palmer *Mickey Never Fails*	43.0
Disney *version of Snow White and the Seven Dwarfs*	43.0
McSwigan *Snow Treasure*	43.0
Seaman *Boarded-Up House*	43.0
Tunis *Rookie of the year*	43.0
Beals *Buffalo Bill*	48.0
Bugbee *Peggy Covers the News*	48.0
Disney *version of Pinocchio*	48.0
Fairy Tales	48.0
McCloskey *Homer Price*	48.0

On the whole, the choices conform somewhat closely to adult standards as to grade level and quality represented in the *Children's Catalog* published by H. W. Wilson; *A Basic Book Collection for Elementary Grades,* American Library Association; *An Aid to Book Selection for Elementary School Libraries,* Illinois State Library; and 500 *Books for Children,* Nora E. Beust. For example, the *Children's Catalog* gives an approximate rating to each title included. "Every one recognizes that some indication as to the relative difficulty of the book is desirable. The grading in the *Children's Catalog* has been carefully considered with the help of the *Right Book for the Right Child,* the *Graded List of Books for Children* and several excellent state and city lists for school libraries. Grading must never be taken too seriously however." The other standard lists mentioned above also include grade designations.

Since most kindergarten children can not read, the kindergarten choices represent stories that have been told to these pupils. In some instances, the child may have heard the story from a phonograph recording, or he may have 'read' the book by deriving meaning from illustrations. Young children, in naming favorite stories, frequently do not designate the means by which they have become acquainted with the tale. This fact is occasionally true of older children also. Boys and girls who saw the moving picture adaptation of *Lassie Come Home* sometimes felt as much ownership of the story as did those who read it. Some pupils after seeing the movie, turned through the book in an effort to capture again the thrills that attended the cinema experience. To them the story was of paramount importance; the means of obtaining it, secondary. Other children who name books associated with movies they have seen, give their responses under similar motivation. However, precaution was taken in the upper grades by encouraging the children to report only the books they had read.

Although the kindergarten list is undoubtedly largely a selection of books that have been read to these children, it is of interest that all the titles are placed in grades I–IV in the many approved standard lists by qualified librarians and educators and by publishers in their various catalogs. Only thirteen per cent of the books in the primary choices (grades I–III) of the present study do not agree with grade placements as given in one or more of these standard references; in the intermediate list eight per cent

do not coincide with standard placements; and in the upper grade list, twelve per cent do not conform with standard listings.

In the primary choices, we find children in the second and third grades reaching up to books of the intermediate listings, such as *The Matchlock Gun, Homer Price,* the *Jataka Tales, To and Again,* and *The Little Lame Prince.* Also in grades IV–VI we discover a few children enjoying books such as *My Friend Flicka,* which the standard bibliographies assign to high-school levels. But some pupils in the intermediate grades are also reading books in the primary lists, such as *Little Toot, Life of Donald Duck* and *Little Fellow.* Again, in the upper grades (VII–VIII) some boys and girls are reading books such as *A Tree Grows in Brooklyn, My Friend Flicka* and *They Were Expendable,* books which generally appeal strongly to older children. But the greatest number of deviations from standard grade placements in the upper grades come from the citation of books of intermediate-grade difficulty such as *Black Beauty, Twig,* Grimm's *Fairy Tales, A Tree for Peter, Secret Garden,* and *Mr. Popper's Penguins.*

Among the fourteen books in the kindergarten list, 78.5 per cent are included in standard lists mentioned earlier; among the forty-six books chosen by the primary grades, 52.1 per cent are found in catalog listings; in the fifty books liked by the intermediate grades (IV–VI), eighty-four per cent appear in these bibliographies; and in the fifty books most enjoyed by the upper grades (VII–VIII), eighty per cent are recognized by these authorities.

In the *Children's Catalog* books assigned a single asterisk are recommended for first purchase in building a new library; these books "have been found to be most generally useful in libraries" and to have "real merit." Those books to which a double asterisk is assigned are the books of "lasting merit which have a universal appeal to children." In the present survey, forty-two per cent of the kindergarten titles are starred in the *Children's Catalog* and 21.4 per cent are double-starred; in the primary choices, five per cent are starred, and 19.5 per cent are double-starred; while the upper grade list contains fifty-four per cent starred and thirty-four per cent double-starred titles.

Thus we find in the primary grade choices the greatest departure from adult standards of literary excellence. This deviation may be accounted for by the numbers of Disney titles, also by the

Gruelle books, the Wehr animated editions of the classics, and other books—by Washburne, Garis, Friskey, Piper and Whiteford—which do not appear in the standard bibliographies.

CHARACTERISTICS OF CHILDREN'S BOOK CHOICES

In the kindergarten and primary lists of favorites, stories about animals predominate. Tales of this kind give a poignant thrill to many children. Whether wild or tame, real or fanciful, these creatures stir the feelings and imaginations of boys and girls. A sense of intimacy and identification leads children to seek a succession of stories about a well-loved animal character. Such favorites are Donald Duck and Mickey Mouse whose fortunes the children pursue in books, in the movies, over the radio and in comic strips.

Second in popularity in kindergarten and primary grades are fairy tales. Fairy tales should be a part of our literary heritage; they have a rightful place in every child's reading. It is well to recall that the word 'fairy' comes from a word meaning 'to enchant'. At times every child needs stories to carry him beyond the world of reality and to find drama, joy and escape in fairy tales. Fairy tales in general (no special collections named) received highest ranking (5.0) in the intermediate grades, and dropped to a low level (48.0) in grades VII and VIII.

Although some teachers and librarians have discouraged the reading of the *Bobbsey Twin Series*, these books appear in nearly every list of books chosen by children. One girl gave this reason for liking them: "They do the things real children do."

Humor in narration and in illustration is characteristic of many of the books chosen by kindergarten and primary children. *Little Black Sambo, Fast Sooner Hound, Five Chinese Brothers, Ferdinand, Donald Duck and His Nephews, Peter Churchmouse, Millions of Cats, Seven Diving Ducks, Make Way for Ducklings, Snippy and Snappy, "Watch Me," Said the Jeep, To and Again, Little Jeems Henry, Homer Price,* and *Peppi the Duck* will bring chuckles and laughter to primary children as well as to their older brothers and sisters.

These books of fun and humor, illustrated with vivid pictures, have sometimes been chosen by educators as 'substitutes for the comics'—that is, they are presented to children whose reading of the comics seems excessive. From these 'substitutes' or

'bridges' adults have endeavored to lead the child to books of more solid substance. It would seem that in this list of favorites, children have spontaneously chosen many of the 'bridge' books. It is for us as discerning parents, teachers and librarians to lead young readers from these bridgeheads to the vast fields of literature where they can begin exciting and profitable explorations that will continue throughout their lives.

A perusal of the favorite titles of the intermediate grades (IV–VI) reveals the gradual maturing of the tastes of these boys and girls. *Donald Duck* and *Mickey Mouse* persist as favorites, but they fall back in rank to give place to *Lassie Come Home, Mr. Popper's Penguins, Black Beauty* and *Silver Chief.* Similar to the primary-grade children, intermediate-grade pupils also like plenty of fun and nonsense in their reading as attested by choices such as the *Mary Poppins* books, *Freddy the Detective, Five Hundred Hats of Bartholomew Cubbins, Five Chinese Brothers,* and *Fast Sooner Hound.* Adventure books appear in this list also; namely, *Robin Hood, Snow Treasure* and *Robinson Crusoe.* And there are stories of real boys such as *Tom Sawyer, Huckleberry Finn,* and the modern *Homer Price* and *Rufus M.* There is also an interest in children of other lands as shown in *Heidi, Good Master,* and *Snow Treasure.*

Evidence of maturing tastes in the upper grades (VII–VIII) is shown in choices such as *Lassie Come Home,* the *Sue Barton* books, *Keystone Kids, Silver Chief, Lad, All American, Caddie Woodlawn, Call It Courage,* and *Treasure Island.* The upper grade list is definitely weighted with books of action and adventure. We should, however, like to find more books in this list similar to Tunis' *All American,* Mean's *Shuttered Windows* and *Tangled Waters,* Felsen's *Struggle is Our Brother,* and Allee's *Susanna and Tristan* in which social issues are portrayed. A continuation of the present survey into the senior high school might have disclosed more choices of this nature.

QUALITY OF BOYS' AND GIRLS' BOOK CHOICES

In general, then, it is clear that these lists are relatively high in merit as is shown by their similarity to lists of meritorious reading. Another evidence of the superiority of the children's choices is the frequency with which the Newbery and Caldecott Awards are cited. In a composite list of the favorites of kindergarten,

primary-, intermediate-, and upper-grade children, 41.6 per cent of all Newbery Awards appeared. Thus, ten of the twenty-four Award books are listed in the children's choices. And five of the eight Caldecott Awards (62.5 per cent) were selected by the children.

The seeming merit of these choices is further substantiated by two other comparisons. Of a list of forty-nine titles selected by the American Library Association from book titles submitted by one hundred fifty librarians, forty-two were found in the present survey.* Furthermore, thirty-three of approximately one hundred books chosen by children of publishers appear in the present study.**

It is obvious that many titles persist generation after generation as favorites. Thus twenty-seven of the one hundred fourteen "best-loved American juvenile books" (1827–1926) mentioned in Jacob Blanck's*** anthology appear as favorites in the present listing. A few of these old-time favorites chosen by children of the present investigation are: *Little Women, Old Fashioned Girl, Adventures of Tom Sawyer, Toby Tyler, Merry Adventures of Robin Hood, Call of the Wild* and *Story of Dr. Doolittle.*

STATUS OF POETRY IN CHILDREN'S BOOK SELECTIONS

To many of us it is a matter of regret that poetry finds so little favor with the children of this survey. Only one book of poetry, *Little Brown Baby*, received enough votes to appear in the composite lists of favorites. The bulk of votes for this book came from a large Negro school in Chicago. It is of interest that in Melcher's recent collection of 'representative children's books' only one book of poetry, Benét's *Book of Americans*, is included.**** And with the exception of Cox's *The Brownies*, not a single volume of poetry is found in Blanck's anthology of best loved American

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* American Library Association. "Most Widely Used Children's Books of 1939–1943." *Chicago Schools Journal*, Vol. XXVII, p. 33.

** "Publishers' Children and the Books They Read." *Publishers' Weekly*, October 27, 1945, pp. 1938–1945.

*** Blanck, Jacob. *Peter Parley to Penrod.* A Bibliographical Description of the Best-loved American Juveniles. New York: R. R. Bowker Co., 1938.

**** "A Children's Book Collection for England." *Publisher's Weekly*, December 29, 1945, pp. 2773–2777.

juveniles.* He contends that "Poetry save for the small doses crammed into the school boy, seems to hold no real place in the reading child's world. Publishers have issued and continue to publish inviting collections of the individual poets and specialized anthologies, but children do not of their own volition turn to poetry." In refutation of this statement, Betzner and Moore** declare that this conclusion may be true of the 'reading' child, but not of the 'listening' child, for poetry makes its greatest appeal to the ear. And surveys such as the one made of the publishers' children's book favorites show that even little children name books of poetry when they have had an opportunity to have poems read to them. Fortunate is the child who has had the heritage of an early acquaintance with poetry; his life is indeed richer for the experience. Surely this lack of poetry in children's reading is a challenge to those of us who believe that a child becomes a better, happier person by having his sensitivities awakened through poetry. Undoubtedly the encouragement of boys and girls to write their own verses will develop a feeling for poetry and will bring about a greater appreciation of poets and their works. Similarly, the inclusion of poetry in superior textbooks may tend to stimulate the child's interest in this type of reading.

SIGNIFICANCE AND IMPLICATIONS OF THIS STUDY

The writers believe that this investigation was well justified and that similar studies should be made annually in order that the adult world of parents, teachers, librarians, authors and artists, may be kept informed of the general trends in the reading tastes of a fairly representative sampling of school children. The high quality of the present bibliography attests to the fine collections of books both in school libraries and in public libraries to which these children have access. It is gratifying to find that the children are taking advantage of their opportunities to enjoy good books.

In the balanced reading program of the modern school, it is recognized that the child's choice of reading materials is an important consideration. This study has made it clear that children

* Opus cited.

** Betzner, Jean and Moore, Annie E. *Every Child and Books.* Indianapolis: Bobbs-Merrill Co., 1940, p. 119.

are characterized by wide and varied interests which lead them to choose a rich and varied assortment of books in many fields. Accordingly, the modern teacher will require access to varied materials if interests are to be satisfied and directed through reading into profitable channels. Teachers must have a rather thorough understanding of children's literature and a wide knowledge of reading materials of various kinds.

Library books and related materials such as audio-visual aids should be selected with a serious concern for their place in a reading program which aims to develop permanent interest in good literature. They should include a wide variety of well-written stories encompassing a reasonable range of interest and difficulty. Thus, they will form an integral and essential phase of a balanced program which has been soundly conceived and developed. Phonograph records, radio broadcasts, and film strips will foster growth in reading power if they are selected to satisfy individual and group needs which have been accurately disclosed.

The reading of magazines and newspapers is also a necessary phase of a balanced reading program. Primary-school teachers report enthusiastically concerning the impetus to learning which results from the use of *Jack and Jill*, and *My Weekly Reader*. In the intermediate grades the use of magazines such as *Story Parade* has been found to heighten interest and foster skill in reading. Of pertinence here is the Army's outstanding success in using its own weekly news magazine, *Newsmap*, and its monthly publication, *Our War*, in teaching men to read.

A balanced reading program, by offering wide reading experience from a variety of carefully chosen materials, will care for individual differences. To locate stories of particular suitability for classes or individuals, teachers are using the *Subject Indexes* and *Guides* such as those developed by the American Library Association. Librarians, too, are working with teachers in an effort to give boys and girls individually appropriate and varied reading. Book companies are also coöperating in this enterprise by publishing good literature at low cost for use in every grade level from the kindergarten to the high school. The *Unit Study Series*, the Follett publications and the *Cadmus Books* are examples of such materials. Other companies, too, are publishing series of books dealing with current topics, such as the *New World Neighbors*, which offer the child stories of literary excellence and,

at the same time, provide a natural relationship with the social studies program. Science stories also receive serious attention in a balanced reading program. Accordingly, centers of interest find expression in periods assigned not only to reading, but also to the social studies and science. To provide additional motivation and relevant extension of experience, the classroom or library in the modern school offers the child access to new books that are rich in elements of humor, excitement, adventure, or surprise.

Thus the teacher's task will involve an unending quest for the right book for the right child. In evaluating the success of this effort, the teacher must consider the child's reaction to reading materials. This study throws light on the child's own appraisal of his reading. Such systematic surveys will help not only in estimating the success of library and reading programs, but also will afford another important source from which to select books of genuine and lasting appeal to boys and girls.

THE EFFECT OF ILLUMINATION ON READING RATE AND COMPREHENSION OF COLLEGE STUDENTS

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INTRODUCTION

In the last twenty-five years numerous investigations have been made on the effect of illumination upon human behavior. The literature takes different trends. One group of investigators assumes that, since the human eye developed under natural illumination out of doors, it requires artificial illumination indoors approaching the natural high level outside in order to function efficiently. Investigators, partially inspired by technical advancement in the efficiency of light sources, recommend an increase in the level of illumination in keeping with these technical advances for all types of visual tasks, based upon their very elaborate experimental work.[5,6,7] One of the experiments often quoted,[11] conducted in the U.S. Post Office, indicates that workers were markedly more efficient with increased illumination up to 7 foot-candles. It has been further shown that visual acuity measured by the ability to distinguish finer details on test charts increases with an increase in illumination up to 100 foot-candles.[2]

Another group, composed chiefly of educators and independent investigators, concludes from its experiments measuring specific aspects of visual performance[1,8,12,13,14] that there is no evidence that an increase in illumination above 10–15 foot-candles, in some experiments above 3 foot-candles[15] with proper adaptation, would produce any increase in efficiency or any less fatigue.

These investigations have included studies of the effect of illumination upon speed and efficiency in production,[11,16] speed of perception,[14] reading rate and eye-movements,[9] metabolic rate and heart-beat.[8]

The present experiments were designed to test whether or not an increase in illumination from 2–3 foot-candles up to 55 foot-

candles (which includes the extremes found in any classroom at Smith College) would have any measurable effect upon the reading rate and comprehension scores of college students in a normal reading situation. In Part I of the experiment it was planned to control neither the student's posture as she read, nor the distance she held her eyes from the printed page, but merely to determine whether, under the usual free conditions of a reading-room, the effects of increased illumination would be evident in the rate and comprehension with which the student read.

Experimental Section

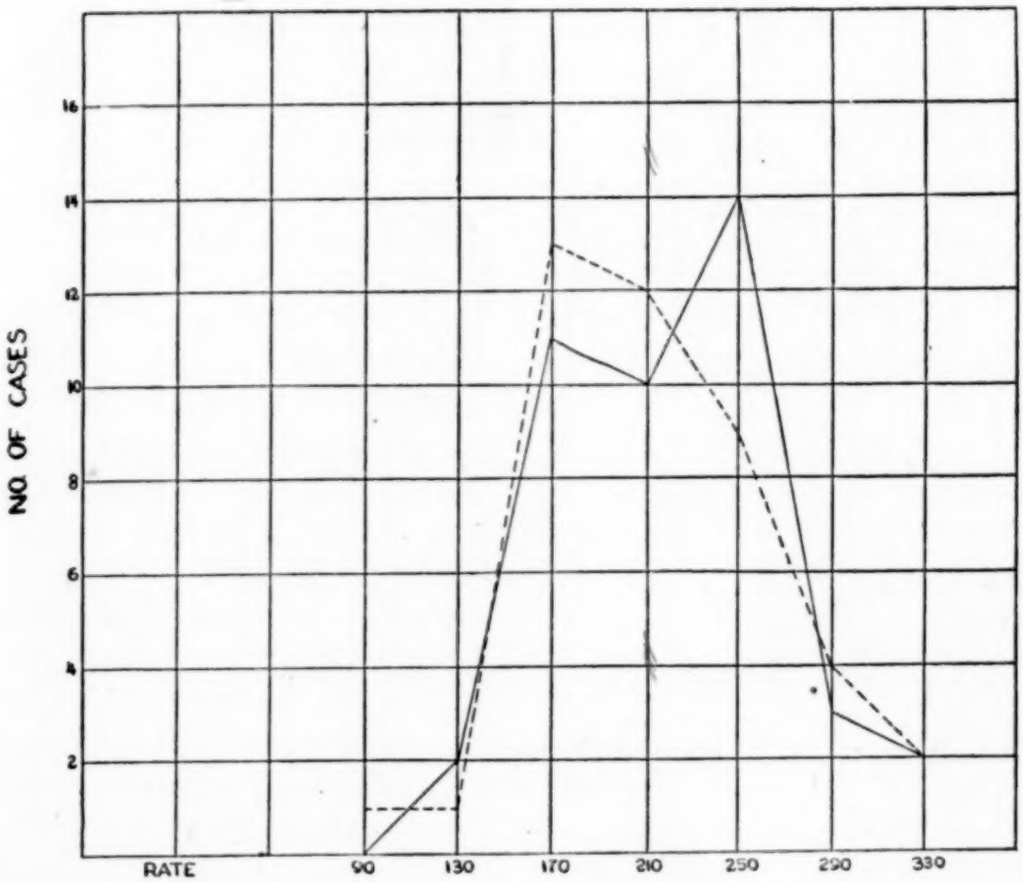
PART I

The first experiment was in the nature of a preliminary to the experiments which followed it. It was devised to see whether or not differences in lighting from 2–3 foot-candles (called 'poor') to 10 foot-candles (called 'average') and to 28–30 foot-candles, (called 'improved') would have any measurable effect upon the reading rate and comprehension scores of students attending Reading Clinic classes. Forty-two students participated in the first part of the experiment and thirty in the second part. Four selections from the Equated Transfer Selections for use with the Harvard Reading films were used for reading material. In the first half of the experiment, students in each Remedial Class were divided into two groups at random. One group read one selection seated in a circle under the semi-direct lighting fixtures, where the light on the surface of the reading material measured 10 foot-candles while the other group read the same material while seated at tables in remote parts of the room, where the light was found to be 2–3 foot-candles. After all students had completed the reading, had recorded the time taken for the reading, and had answered comprehension questions, they exchanged places, so that those formerly under 'good' light now read under 'poor' light, and the reverse, using a second one of the Equated Selections. The results of this part of the first experiment were tabulated. The reading rates and comprehension scores were grouped together according to the lighting conditions under which they were achieved. As each selection was read under both types of lighting conditions, and as some students read the material under

bright light first, others under dim light first, it was felt that variations due to differences in difficulty of the material, and the order in which the material was read would be eliminated when the results were combined in this way.[1]

There was no significant difference between the scores obtained under 10 foot-candles and under 2–3 foot-candles. The average reading rate was 3.1 W.P.M. (words per minute) faster under bet-

FIG. 1

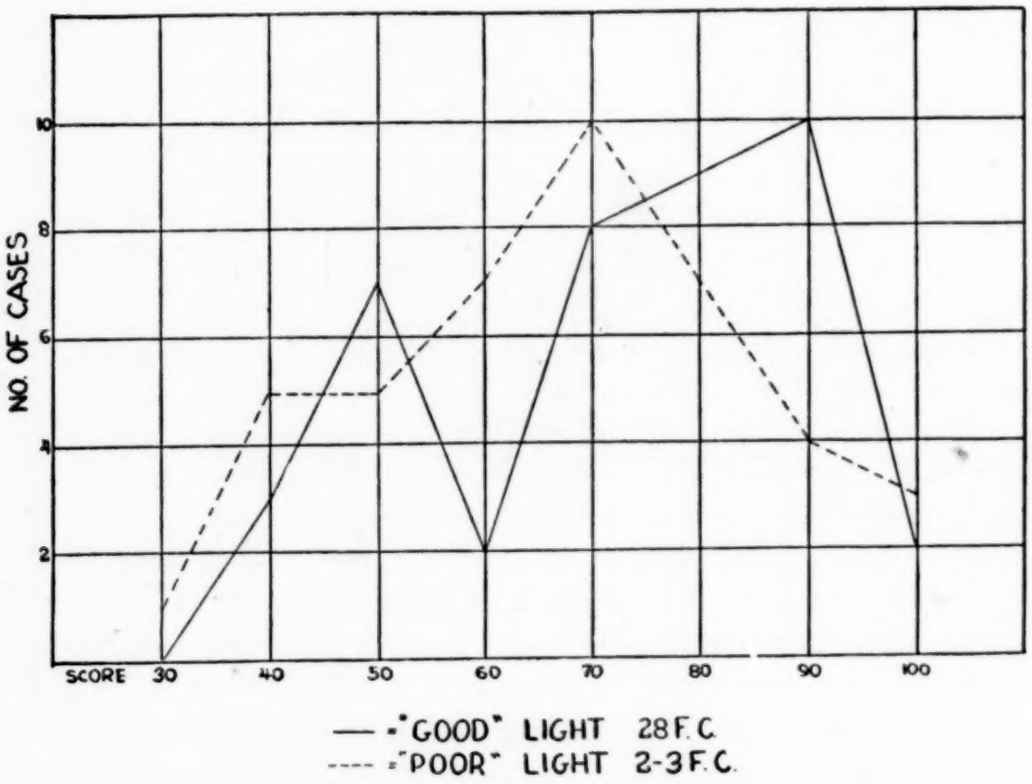


ter light, while the comprehension scores were 4.9 points higher under better light. Median reading rate was 12.8 W.P.M. faster under brighter light and median comprehension scores were 2.1 points higher under brighter light. The results showed greater differences than this when grouped according to selection read, or according to first or second trials, regardless of lighting conditions.

[1] Complete data may be obtained from the authors.

In the second part of Experiment I two new reading selections were used in the same way as in the first part, except that the light was changed from 2–3 foot-candles to 28 foot-candles. The results of this experiment indicated a slightly greater mean difference between the scores obtained under the different lighting conditions than had been found in the first part of the experiment.

FIG. 2



The average reading rate was 6.5 W.P.M. faster under brighter light, while comprehension scores were 3.6 points lower under brighter light. Despite the insignificant differences in the mean scores, the graphs (Fig. 1 and 2) and the median rate scores indicated that there was a tendency for the scores under brighter illumination to be better than under dim light. However, when scores were again grouped according to the selection read, the differences were still greater.

In considering our results, we felt that a more normal student population should be used than we found in the Reading Clinic classes, and that the number of students reading each selection under a particular type of light and the order of the selections should be so arranged that all selections would be read by all students under all lighting conditions.

Thirty-two students from classes in Education volunteered for the second experiment. These were divided into two groups of sixteen each by random selection. Group A read one selection under 28 foot-candles for ten minutes, then two more selections under 3-5 foot-candles for twenty minutes, and one more under 28–30 foot-candles for ten minutes. Group B read first under 3–5 foot-candles, then under 28–30 foot-candles for the twenty minute period, then under 3–5 foot-candles for the last part of the period. Within each group the students were seated in four rows of four students each, and four different selections were used by the group under each set of lighting conditions. Papers were exchanged at the end of each ten-minute period. In this way the material was read by all students under all types of lighting conditions, and in every order.

When the figures obtained from both parts of the experiment are combined so that factors other than illumination are eliminated (Table I), there is no significant difference between reading rate and comprehension scores under 3-5 foot-candles and under 28–30 foot-candles. The average reading rate was 0.5 words per minute slower under brighter light, and the average comprehension score was 4.5 points higher.

Since the number of students in each experiment was small and averages might be thrown off considerably by one or two extremes, medians were calculated. The median scores indicated 11 W.P.M. greater speed and 6.2 points higher comprehension for material read under brighter light.

For the third experiment it was decided to try new material which would require longer uninterrupted reading time, to use brighter light than had been used heretofore, and to use more nearly matched groups. Of an original group of twenty volunteers who came in during the Spring Recess, it was possible to obtain complete data from only eight pairs of students. In this experiment the students were allowed to complete one selection from an unpublished test used at Smith College, and to record

TABLE I.—READING RATE AND COMPREHENSION SCORES FOR THIRTY-TWO STUDENTS UNDER ILLUMINATIONS OF 3–5 AND 28–30 FOOT-CANDLES

Illumination:	3–5 foot-candles				28–30 foot-candles			
Student	Trial 1		Trial 4		Trial 2		Trial 3	
	Rate	Comp.	Rate	Comp.	Rate	Comp.	Rate	Comp.
1	252	80	302	80	324	90	250	80
2	283	50	302	80	302	90	339	70
3	283	70	302	60	297	70	302	100
4	297	30	238	80	226	80	267	70
5	339	50	252	60	252	80	378	50
6	504	70	366	40	454	70	412	70
7	302	50	297	50	349	70	302	60
8	302	60	302	80	283	90	317	70
9	378	90	324	80	366	70	324	90
10	238	60	252	80	250	90	238	80
11	238	50	206	80	226	80	250	40
12	454	80	454	90	366	80	324	90
13	238	60	206	70	216	60	200	60
14	594	80	504	65	542	90	504	90
15	267	100	264	80	267	70	238	100
16	378	50	279	60	302	50	324	90
	Trial 2		Trial 3		Trial 1		Trial 4	
	Rate	Comp.	Rate	Comp.	Rate	Comp.	Rate	Comp.
17	283	30	238	100	206	60	317	20
18	238	50	238	60	226	70	264	50
19	378	70	349	70	349	80	366	50
20	252	50	226	90	200	70	250	70
21	238	80	283	80	264	60	238	90
22	283	50	349	80	339	60	302	90
23	324	60	412	50	279	20	378	80
24	238	50	252	70	206	70	252	70
25	366	60	283	80	324	70	378	60
26	396	50	349	100	378	90	453	70
27	206	60	206	70	206	70	238	80
28	366	60	378	50	378	70	412	60
29	283	70	279	50	378	70	302	60
30	324	80	297	60	349	50	324	80
31	349	70	366	50	412	70	302	70
32	324	70	317	60	238	40	283	70
Mean under 3–5 foot-candles:			310.5	66.2	Mean under 28–30 foot-candles:		309	70.7
Median:			298	69.5	Median:		309	75.7

Selections used: 4, from Equated Selections for use with Harvard Reading films.

Conditions: During any one trial, each of the four selections was read by four students.

their time in seconds. The average scores for the two groups were 306 W.P.M. and 333 W.P.M., comprehension scores 66 and 63, and Michigan Reading Test Scores of 60 and 63.8, respectively. It is evident from these figures that we did not have perfectly matched pairs, but they were as closely matched as possible from our small number of volunteers. The entire group of twenty was tested together under 7 foot-candles when these figures were obtained. For the second part of the test Group A read two more selections from the Smith test, plus a second form of the Michigan Speed of Reading Test under 50 foot-candles, while Group B was given this material under 3 foot-candles. The Michigan Test was given at the end of the period, after the students had been reading or working on questions to be answered for at least thirty-five minutes under the given set of lighting conditions. Although the groups were not evenly matched, it was possible to compare each group with its own former record. On the second set of tests, the averages for Group A, under 50 foot-candles, dropped 21 W.P.M. on fiction, and 93 W.P.M. on non-fiction, but increased 27 and 11 points in comprehension. The averages for Group B, under 3 foot-candles, dropped 37.8 W.P.M. on fiction and 63 W.P.M. on non-fiction, while average comprehension scores increased 22 and 10 points, respectively. Michigan Test scores after adequate time had been given for complete adaptation to light, show even less change. If anything, the dimmer illumination seemed to be leading to higher rate and comprehension scores.

Still unsatisfied with our negative findings, which we felt indicated that chance was playing a greater rôle than illumination in our data, we considered two more possible causes for our results. Our lighting in the third experiment was not perfectly free from glare at 50 foot-candles, as we had been using semi-direct lighting plus indirect lighting, and, in the second place, the Michigan Test, which utilizes green print, might have been easier to read than one would expect under 3 foot-candles because our lights were dimmed with a rheostat, and there was a color change toward yellow.

Experiment 4 was designed as a final experiment, where we hoped to improve the lighting conditions and control more of the other variables which might have been causing our negative results.

In this experiment we hoped to approximate the conditions of an ordinary classroom or reading-room, using the freshman Hygiene text[10] for reading material, and multiple choice questions constructed for the purpose of this experiment. The students were twenty-seven volunteers who agreed to come for both parts of the experiment. They were given selections from the book which they had not previously read. At the first meeting a sample reading selection and a test was given under 10 foot-candles to familiarize the students with the techniques to be employed, and the type of question to be answered. This also gave the experimenters some idea of the reading rates of the students. The original group was then divided into two nearly matched groups. In two different meetings each student then read under 50 foot-candles or under 3 foot-candles first, then under the alternate illumination in the second trial. Selections were also presented in alternate order to all of the group at any one meeting. The experimental periods were just under one hour. Results will be found in Table II. It will be seen that the two groups were nearly equal in rate and comprehension scores on the pretest under 10 foot-candles. Most students read faster during the actual tests than they had during the pretest, and with poorer comprehension scores. This may have been because they did not know what to expect for test questions, so read the pretest more slowly, and because it was a shorter selection, they remembered it better. It is also possible, that, because it was a short selection, they did not attain their normal rate.

Considering the results from Group II, the average reading rate scores show no significant difference between bright and dim light, a difference of 3 W.P.M. favoring dim light, and a 7.1 point difference in comprehension scores favoring bright light. Group I, on the contrary, showed a much greater difference between reading rate and comprehension scores under the two conditions, greatly favoring the dim light. If the average scores for the two groups are combined, this still favors the dim light by 31.9 W.P.M. and 6.5 points in comprehension. The examiners learned at the time when the test was given to Group I, that three of the students had heard a lecture on the material covered by the test within the week that the test was given. If their scores are eliminated from the results of the group and the final average, one finds that the average difference in reading rate is only 3.2 words

TABLE II.—RATE AND COMPREHENSION SCORES FOR TWENTY-SEVEN STUDENTS UNDER ILLUMINATIONS OF 10, 50 AND 3–5 FOOT-CANDLES

Illumination:	10 foot-candles		50 foot-candles		3–5 foot-candles	
Group I	Pretest		Selection 2		Selection 1	
	Rate	Comp.	Rate	Comp.	Rate	Comp.
*1	174	80	208	60	322	90
2	245	100	182	100	225	100
3	245	100	289	60	282	100
4	245	60	352	70	348	100
5	204	100	220	55	248	100
6	188	100	206	70	286	100
*7	204	100	287	65	340	50
*8	163	80	198	60	314	80
*9	245	100	207	85		
10	188	100	220	80	432	100
11	196	100	190	65	226	90
12	272	80	352	55	348	80
13	223	80	232	80	282	90
Mean:	214.7	90.7	241.7	68.7	304.5	90
Mean, excluding *	224.6	90.1	281.1	67.7	287.2	90

Group II	Pretest		Selection 1		Selection 2	
	Rate	Comp.	Rate	Comp.	Rate	Comp.
14	204	100	275	90	268	75
15	153	100	206	70	201	95
16	223	100	275	80	263	85
17	174	100	236	90	224	85
18	188	100	226	90	263	70
*19	174	100	220	90		
20	204	100	218	60	207	65
21	204	80	218	70	226	80
22	153	80	284	100	227	70
23	306	100	246	100	224	90
24	188	80	197	100	223	75
25	188	60	210	80	226	75
26	245	100	308	60	362	60
27	223	100	272	80	274	60
Mean:	201.9	92.8	242.2	82.8	245.2	75.7
Mean, excluding *	204	92.3	243.9	82.3	245.2	75.7

Mean for Groups I and II	208.1	91.8	242	76.1	273.9	82.6
Mean for Groups I and II excluding *	212.5	91.8	259.1	76.3	262.4	81.6

Selections used were specially prepared materials from the freshman hygiene text.[10]

* Students 1, 7, and 9 heard a lecture on the material given them as a test under 3–5 foot-candles, three days before the test. Students 8 and 19 not complete the tests.

per minute, and in comprehension score 5.3 points favoring dimmer illumination, which is, again, an insignificant difference.

In each experiment great care was taken to control the relative difficulty of the selections read, the attitudes of the students, and their familiarity with the techniques to be employed in the experiment. Nevertheless, a lecture heard on the subject covered in one of the selections caused the reading rates of three students to double, while any variations attributable to different lighting never changed it more than a fraction of a per cent, or no more than one might expect to happen by chance.

PART II

A second part of the experiment included a survey of the illumination preferred by students when they could control the light from an indirect lamp, with possibilities of variation from 0 to 250 foot-candles. The room was lighted by an indirect ceiling fixture, in addition to a table lamp which the students controlled, so that there was no great contrast between the light under which the subjects read, and the light in the surrounding area. The wide range of choices is given in Table III, where it will be seen that students almost all selected degrees of illumination well above the maximum usually found in reading rooms, and above that under which their most efficient reading had been done.

DISCUSSION

The findings of this experiment lend support to the conclusions of Tinker,[12,13] Atkins[1] and McFarland[8] that intensities of illumination above 10–15 foot-candles will not lead to greater efficiency in accomplishing visual tasks, and they are in disagreement with some of the statements of others recommending greatly increased illumination intensities for reading.[6]

Our methods of testing were different. The positions of the students were uncontrolled and they were free to adapt themselves to the different conditions of illumination. Postures changed with decrease or increase of illumination intensity. Under brighter light students appeared to be more relaxed although their maximum efficiency in reading was attained at lower intensities. There were also wide individual differences in response to variations in illumination. One student doubled her reading rate attained with 10 foot-candles when the illumination

TABLE III.—AMOUNT OF LIGHT PREFERRED BY STUDENTS FOR READING DICTIONARY PRINT, AND PRINT ON EQUATED READING SELECTIONS USED IN EXPERIMENTS DESCRIBED IN PART I

Foot-candles	Number of Students Preferring this Lighting	
	Dictionary Print[1]	Equated Selections[2]
0–10	1	2
11–20	5	6
21–30	7	7
31–40	5	12
41–50	12	6
51–60	11	9
61–70	5	8
71–80	10	8
81–90	3	5
91–100	3	4
101–110	4	0
111–120	2	5
121–130	0	4
175	1	0

Median number of foot candles for:

Dictionary Print—54.5
Equated Selection—56.2

[1] Large *Webster Merriam Dictionary*—5½-point Agate type.

[2] Equated Selections for use with Harvard Reading Films—14-point English type.

was increased to 50 foot-candles. Another said that she felt uncomfortable under the bright light. Many complained that they felt it a strain to read with 2–3 foot-candles, but with 10 foot-candles they seemed to be satisfied.

No correlation was found between the illumination intensity preferred and the illumination intensity under which the students worked most efficiently.

Other experimenters[3,4,9] have found that visual acuity of defective eyes increases or decreases according to changes in illumination intensities and it may be assumed that in an unselected group of students some with defective vision were included, which may have influenced our results. On the other hand the influence should be slight, because the increased illumination improves the near-point vision of presbyopic eyes, and not of non-presbyopic eyes.[4]

SUMMARY AND CONCLUSIONS

1) The experiments were designed to determine the effect of changes in illumination intensities from 2 to 55 foot-candles upon the reading rate and comprehension scores of college students.

2) Reading efficiency measured by rate of reading and comprehension scores in a normal reading situation did not increase by a measurable amount with increased intensity of illumination.

3) There was a slight indication of increase in comprehension with increases of illumination from 2 to 10 and from 3 to 30 foot-candles.

4) There were wide individual variations in reading efficiency under different conditions of illumination.

5) Students do not necessarily read most efficiently under the illumination intensity which they prefer.

6) Given sufficient light to distinguish print (2–3 foot-candles), and freedom to read the material at the preferred distance from the eyes, almost any factor other than illumination seems to play a more important rôle in reading efficiency than illumination.

7) The very low illumination intensities, 2–3 foot-candles, are not to be recommended for reading because of their effect upon posture, rather than because of their effect upon reading efficiency.

8) Further studies need to be made and published by independent investigators upon reading under normal free conditions

in order to balance the widely publicized but not adequately substantiated recommendations for greatly increased intensities of illumination.

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A STUDY OF CHILDREN'S MATHEMATICAL INTEREST QUESTIONS AS A CLUE TO GRADE PLACEMENT OF ARITHMETIC TOPICS

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The problem of this study developed out of the questions asked by children on aviation. These questions were secured as a guide to indicate what should be included in the Civil Aeronautic Administration's source book which was written by the Stanford University School of Education staff for textbook writers and course-of-study makers.

The technique and procedures to be followed by those collecting the questions was determined by Norman Fenton, Professor of Psychology (and Mental Hygiene) at Stanford University. The data received by Dr. Fenton and his staff of research workers were compiled, classified, and submitted to all persons taking part in the project.

The locations of the schools from which the children's questions were derived are as follows: San Bernardino, San Francisco, Kern County, San Diego, Palo Alto, Menlo Park, La Jolla, Palo Verde, San Luis Obispo, and Monterey in California; Seattle and Bellingham in Washington; and Eugene, Oregon.

A possible limitation to the major study is recognized by the location of these schools. Ideally the questions should have come from every section of the United States. Part of the possible criticism of the sampling which the reader may want to make can be discounted when one considers the children taking part in the study. The majority of the children undoubtedly have lived on the Pacific Coast since birth. On the other hand an appreciable number have recently come from practically every state in the Union and to considerable degree were influenced by their earlier environment. There are no data showing to what degree aviation has been a part of that environment for children born elsewhere than on the Pacific Coast. Generally speaking, however, the Pacific Coast children are very much aware of the airships and lighter-than-air craft about them. How much of this awareness

has been accentuated by units of teaching on aviation is not known from the data collected.

The children numbered 4,250. They included three hundred fifty pre-primary and five hundred ninth-grade pupils. In this study the grade levels include I through VIII or a total of 3,262 children. The total questions asked by the 3,262 children were 21,886. Of this amount 6,410 questions were selected as being mathematical.

The writer found that the rough classification of the children's questions made for guidance to the Civil Aeronautic Administration Project staff often distorted and duplicated the true essence of those questions. It was felt necessary therefore to base this study on the original data.

GENERAL OVERVIEW

In tabulating the interest questions of 3,262 children, grades I through VIII, there was found to be a wide range of chronological ages within each grade level. A preliminary analysis revealed the fact that to discover typical interests at each level, and trends throughout, it would be desirable to remove the over- and under-age groups from the analysis.

In general, up to the fourth grade there appears to be a trend established that under- and over-aged children as a group are interested in number first, followed by size and speed. In the fourth grade the under-aged girls choose as their preference time, size, and number. The under-aged boys in the fourth grade prefer number first followed by size, then time. The over-aged boys in the same grade have still another order of interest indicated by a first choice in time, followed by number and size.

The same general inconsistency continues throughout all the grades. This inconsistency makes it quite difficult for the reader to follow through on any trend of thought. Since over- and under-aged groups of children in the last analysis cloud the real issue, they are not included in the general discussion of trends or the lack of them. However, the over- and under-aged children's frequency count will remain in each of the first eight grade tables.

FIRST GRADE QUESTIONS

The children in the first grade asked a total of 1070 questions concerning many subject fields. Only sixty-six questions met the

criteria of what was mathematical. Within the subject area of reading there were, however, many single words or phrases that could be considered as having mathematical meanings. For the most part these words have been included in the first-grade arithmetic vocabulary, but they were not made a part of the frequency count in this study.

TABLE I.—CLASSIFICATION OF FIRST-GRADE CHILDREN'S QUESTIONS ABOUT MATHEMATICS

	Girls		Boys			Total
Age	*6	7	6	7	8	
Number						
Quantity	5	3	9	7		24
Order	1	1	5	1		8
Size						
Height	7	1	2	3	1	14
Over-all measurement	1		1			2
Weight			1			1
Length			1	1		2
Volume				2		2
Time						
Min., hours, days, etc	2	1				3
Speed, M.P.H., R.P.M.	2	1	3	4		10
Totals	18	7	22	18	1	66

* Ages range from six years to six years eleven months inclusive, etc.

By eliminating the questions that clearly have reference to the vocabulary concepts and also those of the over- and under-aged children from the first-grade analysis, sixty-six out of the original 1070 questions remained. These questions were then classified and found to fall naturally into interest groupings of number, size, and time, as shown by Table I.

According to Table I, thirty-two questions, or nearly fifty per

cent, were about number reading, counting, and meaning of numbers. The type of questions asked by these boys and girls was predominantly about the passenger load and the number of men in the crew of the airplane presented to them in the interview.

This same leading question of 'how many' is met over and over again in denominate numbers and measurement. Children in the first grade show a keen interest in height. The frequency count of this item is twenty-per cent of the total questions asked. "How high or low is the airplane flying?" constitutes the majority of the questions in this classification.

A third revelation brought out by the first-grade children pertains to speed. "How fast is it (airplane) going, or can it go?", is asked by approximately one-sixth of the total number of children asking mathematical questions.

A rather striking omission on the part of all first-grade children is in the matter of money. There was not a single reference as to how much anything costs.

SECOND-GRADE QUESTIONS

The second-grade children show a definite growth in maturity if the diversity of questions asked is any criterion by which to judge. These children of all chronological ages have asked a total of one hundred eighty-seven mathematical questions out of a total of seven hundred seven questions. The range of chronological ages which will be discussed, however, are the seven- and eight-year-old boys and girls who have asked a total of one hundred seventy-eight questions.

As in the case of the first grade, number indicating quantity is quite important. Approximately forty per cent of the total mathematical questions asked dealt with quantity. The remainder of the questions (see Table II) indicates a greater concern of these second-grade pupils in all phases of size (measurement).

The second-grade children show a definite interest in size, particularly in length, height, and in speed.

The content of the mathematical questions on length is in regard to the length of airplanes, wing span, propellers, and runways.

The type of question asked by both boys and girls on height was of a general nature, such as "How high is that plane?" or, "How high up is it?"

Where length, width, and height were not specifically mentioned a fourth topic under size was decided upon and called overall measurement. Such questions as "How big is that plane?", and "How big is an airfield?", or "How big is the runway?" were included in the topic of overall measurement. If the

TABLE II.—CLASSIFICATION OF SECOND-GRADE CHILDREN'S QUESTIONS ABOUT MATHEMATICS

	Girls			Boys				Total
Age	7	8	9	6	7	8	9	
Number								
Order			1			1		2
Quantity	6	9	1		28	24	3	71
Size								
Length (inch, ft., yard)					7	4		11
Height (inc. altitude)	7	5	1	1	13	6		33
Distance (miles)					2	1		3
Volume, liquid		2			3	1		6
Weight	1	1			5			7
Overall measurement	6				2	8		16
Time								
Hrs., mins., days, etc.	1				1	1		3
Speed, M.P.H.	9	3			12	8	1	33
Money						1		1
Total	30	20	3	1	73	55	4	186

research worker recording the questions of these children had followed through by asking what was meant it would have helped considerably in the analysis. In the absence of this information the interpretation has been to include within overall measurement the three major dimensions of length, width, and height. This interpretation is not completely satisfactory since many children in their explanations describe dimensions in terms

of comparison with some object in their environment. In such cases all comparison are relative and the vocabulary concept of 'How big' is not in terms of common units of measurement.

Speed in the second grade is comparable to the frequency distribution in the first grade. Within the limits of reasonable doubt the unit meant within this classification is miles per hour. Children have repeatedly asked "How fast it is going?"

Another more specific unit of measure that appears to have some significance to younger children is that of volume. In practically every instance children have asked how many gallons of 'gas' is carried.

Money interest appears for the first time in this grade, and then only with an older child. One eight-year-old boy asked the cost of an airplane.

In a summary of the mathematical interest expressed by the second-grade children in this study there is a readiness to expand their concepts of quantity, height, length, overall measurement, and speed. The units of measure involved are feet and miles per hour. In addition, there is an interest over the first-grade children in volume, weight, and distance.

THIRD-GRADE QUESTIONS

In the third grade two hundred fifty-four children asked a total of 1416 questions of all types. Of this total there were only one hundred ninety mathematical questions for all ages. The typical group in this grade, eight- and nine-year-old pupils, asked a total of one hundred sixty-seven questions.

These children show by their questions a consistent desire to know how many men, passengers and, to some extent, guns there are in the picture or model of airplanes presented to them during the individual interview. Many of these children desire to know the number of guns and bombs carried by the Flying Fortress, P-38, and other airplanes. In addition to the military questions there is shown an increased attention to the mechanics of an airplane as revealed by the questions on the number of parts in the engine, the number of horsepower, and the number of engines.

The general mathematical classifications of number, size, and time are also suitable for the mathematical interests in this grade. As will be seen in Table III, the children have a first preference for size with a second equal interest in number and time, includ-

ing speed. In the first and second grade the predominant interest was in number, followed by size and time.

TABLE III.—CLASSIFICATION OF THIRD-GRADE CHILDREN'S QUESTIONS ABOUT MATHEMATICS

Age	Girls			Boys			Total
	8	9	10	8	9	10	
Number							
Quantity	9	6	2	16	19	9	61
Order					1	1	2
Size							
Length	2	1		2	7		12
Height	4	4		9	7	3	27
Volume				1	3	1	5
Area				1			1
Weight		1		1	7		9
Overall Measurement	3	1	1	2	5		12
Thickness		1		1		1	3
Distance				2		1	3
Time							
Time	6	1			1		8
Speed	8	1		12	21	4	46
Direction					1		1
Totals	32	16	3	47	72	20	190

When separate topics under number, size, and time are considered, it is then found that the third-grade pupils are more interested in quantity, followed by speed, height, length, overall measurement, weight, time, and volume.

FOURTH-GRADE QUESTIONS

In the first three grades each child was interviewed and his questions recorded, but in the fourth through the eighth grade

each pupil wrote his own question according to the standardized procedure provided for in the survey. The pupils of grades IV and V were given twenty-five minutes to write any questions they desired to ask about aviation. Within this time limit, 526 fourth-grade boys and girls of all ages asked a total of 3825 questions of which 1308 were classified as mathematical. The median aged group, nine- and ten-year-old children, asked a total of 1189 mathematical questions.

TABLE IV.—CLASSIFICATION OF FOURTH-GRADE CHILDREN'S QUESTIONS ABOUT MATHEMATICS

Age	Girls					Boys					Total
	8	9	10	11	12	8	9	10	11	12	
Number											
Quantity	1	99	76	8	1	7	138	74	21	2	427
Order							1				1
Size											
Length	1	15	11				19	11			57
Width		3	1				1	3			8
Height	4	51	23	2		1	47	28	5		161
Distance		5	7	2			5	9	1		29
Weight		24	9				16	9	1		59
Thickness							1	1			2
Volume		22	11			1	14	5			53
Area							1				1
Temperature			1								1
Overall meas.	2	32	24	3		1	26	9	6	1	104
Time											
Time		40	23	2			22	14	3		104
Speed	5	60	30	10		1	87	65	20		278
Money	1	10	2				4		4	1	22
Total	14	361	218	27	1	11	382	228	61	4	1307

The order of interest preference according to the general classifications in the fourth grade is somewhat similar to that of the third-grade pupils. In the fourth grade the order of children's interests were size, number, time, and money. (See Table IV.) Within these general classifications the separate topics of interest are centered in quantity, speed, height, time, overall measurement, weight, length, volume (liquids), distance, and money.

Quantity, as was the case of the preceding grades, is primarily on the subject of airplanes, number of passengers, size of the crew, and the number of guns carried on military airplanes. Although the general pattern of quantity questions for the most part are the same, there was within the topic of quantity an indication of advanced maturity in the many additional separate questions of a heterogeneous nature asked by the fourth-grade children.

Under the topic of size the general content of the questions included measurement in terms of the unit in miles, pounds, tons, degrees, square feet, and gallons. Speed terms were quite general, such as "how fast" and "what is the speed?". Few specific airplane speeds were requested. Under time the units were hours, days, weeks, months, and years to travel from place to place and also the length of training period for the crew of an airplane.

The content of the money questions dealt with the cost of an airplane.

In summary, the fourth-grade pupils are interested in the mathematical classifications of number, size, time, and money. The topics of special interest to these children, in order of interest under the mathematical classifications, are quantity, speed, height, time, overall measurement, weight, length, and volume.

FIFTH-GRADE QUESTIONS

From a total of four hundred seventy-six fifth-grade children there were 1551 mathematical questions asked out of a total of 3448 questions in all subject areas. The ten- and eleven-year-old pupils, the median group, asked a total of 1368 mathematical questions.

The same general pattern remains evident in this grade. Number, size, time, and money are still the interest of children. (See Table V.) The children's order of preference for the various classifications are number, time, and money.

According to Table V, quantity, under number, leads all other interests in specific topics. Topics next of interest are speed, height, time, weight, overall measurement, volume, length, and distance. Of lesser interest are such items as money, width, area, and thickness.

TABLE V.—CLASSIFICATION OF FIFTH-GRADE CHILDREN'S QUESTIONS ABOUT MATHEMATICS

Age	Girls						Boys					Total
	9	10	11	12	13	14	9	10	11	12	13	
Number												
Quantity	5	141	55	32	2	1	30	160	116	9	3	554
Size												
Length	1	33	1	2				16	11	2		66
Width		4	2					1	3			10
Overall	5	32	8	4		1	1	16	11			80
Height	2	65	28	6			5	50	32	9		197
Distance	2	14	14	1		1	3	20	9	4	1	69
Volume	1	14	16	3				17	19	3		73
Weight	1	17	13	1		1	3	32	13	1		82
Area									1			1
Thickness									1			1
Time												
Time	2	45	17	2			2	40	19	3		130
Speed		51	36	4	4		7	102	65	10	1	280
Money				1				5	1	1		8
Total	19	416	190	56	6	4	51	461	301	42	5	1551

The content of the quantity questions asked by the fifth-grade pupil's are similar to the content of children's questions in the preceding grades. In addition, however, more emphasis is placed on the number of bombs an airplane can carry, and on the number of parts of an airplane.

The topic of speed of airplanes in general has been supplemented by the speed of specific airplanes, speed of propellers, diving speeds, and the speed of blimps.

Height questions remain rather constant. Children want to know "How high does an airplane go?", "How high before a pilot needs oxygen?", and the highest altitude attained by any airplane.

In questions on time the interest is centered around the training period of pilots, length of time between refueling, the time it takes to get from place to place, time a given amount of fuel will last, when specific airplanes were invented, and a rather indefinite question on "How long can a plane, blimp, or glider stay up?"

Weight questions are almost entirely on the weight of bombs, airplanes, and tonnage load of an airplane. Overall measurement questions are indications of immaturity. The questions all begin with "how big." No specific measurement in any case is asked for. The questions of volume in this grade, as well as those preceding, are on the fuel consumption of airplanes, or the amount of fuel ('gas') needed to travel to a designated place.

Length is primarily on the subject of length of an airplane, aircraft carrier, blimps, and runways. The questions on distance are predominantly on "How far can an airplane travel on a tank of 'gas'?" or on a specific number of gallons of 'gas'. Money questions remain the same: "How much does an airplane cost?"

SIXTH-GRADE QUESTIONS

The number of sixth-grade pupil's totalled five hundred twenty-one with chronological ages to fourteen. These children asked a total of 3811 questions of which 1261 were classified as mathematical. The median age group, eleven- and twelve-year-old children, asked a total of 1106 mathematical questions.

Size, number, time, and money are the order of interest for the sixth-grade children. A very minor interest is also shown in position, direction, and instrument reading. (See Table VI.)

The subject-matter of the questions on each of the topics is identical to those asked by the fifth-grade pupils. Of interest to the reader may be the type of questions asked on position, direction, and instrument reading. The question on position concerns the pilot's method of finding his way from one place to another. Direction questions are on "the angle of plane in a dive, and angle

TABLE VI.—CLASSIFICATION OF SIXTH-GRADE CHILDREN'S QUESTIONS ABOUT MATHEMATICS

	Girls					Boys					Total
Age	10	11	12	13	14	10	11	12	13	14	
Number											
Quantity	15	135	63	1	3	8	74	84	10	2	393
Order	1	2									
Size											
Length	2	19	7	1		1	12	6	1		49
Width	1	1							1		3
Overall		12	7			3	5	4	2	1	34
Height	8	52	21	4	2		41	33	2		163
Distance	1	19	4			1	19	20	2		66
Volume	1	11	8				8	12			40
Weight	4	22	17	1	1	1	20	13	6		85
Thickness						1					1
Area		3									3
Time											
Time	3	37	16	2		1	7	14	1		81
Speed	9	64	41	2	4	11	71	68	21	1	292
Position		1	1				2				4
Direction	1		1					2			4
Instrument Rdg			1								1
Money	9	10	5		1	1	1	10			37
Total	55	388	192	11	11	28	260	266	46	4	1261

when a plane is going up." The one question on instrument reading is, "what instruments are used in measuring airline distance?"

SEVENTH-GRADE QUESTIONS

There were four hundred sixty-six children in the seventh-grade group ranging from eleven through fifteen years of age. These pupils asked a total of 4335 questions of which 1464 were considered mathematical. The median group, age twelve and thirteen, asked a total of 1262 mathematical questions.

The order of interest preference of the seventh-grade pupils in the general classifications (Table VII) are somewhat different than for the preceding grades. The children of the seventh grade are interested first in time (includes speed), size, number, and money. A slight interest is also shown in instrument reading, direction, and position.

In specific topics, the children are interested first in quantity, followed by speed, height, time, volume, weight, distance, length, and overall measurement. Additional topics of lesser interest are temperature, circumference, and thickness.

EIGHTH-GRADE QUESTIONS

The four hundred thirty-two pupils in the eighth grade have asked a total of 3274 questions of which 891 are mathematical. The median aged group, age thirteen and fourteen, asked a total of 799 mathematical questions.

The mathematical interest preference according to the general classifications (Table VIII) of the eighth-grade boys and girls of the median age group is size, time, number, and money. Pressure and direction are also mentioned.

The topical order of interest is in quantity, speed, height, time, weight, distance, volume, overall measurement, and area.

SUMMARY: MATHEMATICAL INTEREST OF CHILDREN BY GRADE LEVELS ACCORDING TO THE MATHEMATICAL CLASSIFICATIONS AND TOPICS WITHIN THEM

By Classification

The outstanding interests of all the children in the first grade through the eighth, with one exception, according to the classifications used in this study appear to be in size, number (quantity

TABLE VII.—CLASSIFICATION OF SEVENTH-GRADE CHILDREN'S QUESTIONS ABOUT MATHEMATICS

Age	Girls				Boys					Total
	11	12	13	14	11	12	13	14	15	
Number										
Quantity	2	126	50	10	10	123	40	16	5	382
Order	1					1				2
Size										
Length	1	16	4			18	2	3		44
Width		1	2							3
Overall		15	1	2		13	6	3	1	41
Height	5	86	32	12	4	57	24	13	1	234
Distance	1	23	6	2	1	24	9	7		73
Thickness	1	1								2
Area		2				2				4
Volume	3	37	8	1		24	6	2		81
Weight		27	8	4		26	10	5	2	82
Temperature		1		1						2
Circumference						2		1		3
Direction						2				2
Position							1			1
Money		5	4	1		11	3	3		27
Instrument Rdg.						2	1			3
Time										
Time	1	69	41	13	3	37	14	7	3	188
Speed	6	81	21	5	9	94	43	22	9	290
Total	12	490	177	51	27	436	159	82	21	1464

TABLE VIII.—CLASSIFICATION OF EIGHTH-GRADE CHILDREN'S QUESTIONS ABOUT MATHEMATICS

Age	Girls							Boys						Total
	11	12	13	14	15	16	19	11	12	13	14	15	16	
Number														
Quantity		11	63	23	1		2	2	3	57	39			201
Size														
Length			11	4						9	9			33
Width			1											1
Thickness										1				1
Overall		4	7	1						11	11			34
Height	1	12	54	14	1	1	1		1	43	14	1	1	144
Distance		3	7					1	4	32	12			59
Weight		4	19	4	2		1		1	17	13			61
Volume		1	12	6						10	5			34
Area			3							1				4
Pressure										1	2			3
Direction		1	2						1					4
Time														
Time		4	58	17	2			1	3	32	16	2		135
Speed	1	4	28	8	3			1	7	49	40	1		142
Money			9	3					2	17	4			35
Total	2	44	274	80	9	1	4	5	22	280	165	4	1	891

primarily), time (including speed), and money. The exception is money which appears to have no interest for the children in the first and third grades.

The classifications of direction, position, instrument reading and pressure vary with grade levels. Direction is of interest to children in the third-, sixth-, seventh-, and eighth-grade levels.

Position and instrument reading are of interest to children in the sixth and seventh grade. Pressure holds interest for the children in the eighth grade.

By Topics

The subtopics of size are somewhat heterogeneously placed according to grade levels.

Topics and Grade Level

A) Width is of interest to children in the fourth through eighth grade or girls ages 9–13; boys ages 9–11.

B) Distance is of interest to children in the second through eighth grade or girls grade IV–VIII, ages 9–13; boys grade II–VIII, ages 7–14.

C) Volume (liquid) is of interest to children in the first through eighth grade or girls grades II–VIII, ages 8–14; boys grades I–VIII, ages 7–14.

D) Thickness is of interest to children in the third through eighth grade or girls grade III and VII, ages 9 and 12; boys grade III, IV, V, VIII, ages 8–11 and 13.

E) Area is of interest to children in the third through eighth grade or girls grade VI–VIII, ages 11–13; boys grade III, IV, V, VII, VIII, ages 8, 9, and 11–13.

F) Circumference is of interest to children in the seventh grade or boys twelve years old.

G) Temperature is of interest to children in the fourth and seventh grade or girls ten and twelve years old.

H) Length is of interest to children in all the grades or girls grade III–VIII, ages 8–14; boys grade I–VIII, ages 6–14.

I) Overall measurement is of interest to children in all the grades or girls and boys grades I–VIII, ages 6–14.

J) Height is of interest to children in all the grades or girls and boys grades I–VIII, ages 6–14.

K) Weight is of interest to children in grades I through VIII or girls grades II–VIII, ages 7–14; boys grades I–VIII, ages 6–14.

Sex and age partially but not wholly invalidates the grade ranges.

Classifications by Age and Sex

At all median ages and sex for each grade level children are interested in the general mathematical classifications of size,

number, and time (including speed). In the remaining general classification items, interest according to median ages and sex are varied to such an extent that no general pattern or trend can be established.

The following is an attempt to illustrate the interest diversification of the mathematical classifications other than the above according to age and sex:

Classification According to Age and Sex

A) Money—Boys age 8–14 and girls age 9–14 or boys grades II, IV–VIII, 4–8, girls grades IV–VIII.

B) Direction—Boys age 9 and 12 and girls age 12 and 13 or boys grades III, VI, VII, girls grades VI, VIII.

C) Position—Boys age 11 and 13 and girls age 11–12 or boys grades VI, VII, and girls grade VI.

D) Instrument Reading—Boys age 12–13 and girls age 12 or boys grade VII and girls grade VI.

E) Pressure—Boys ages 13 and 14 in the eighth grade.

Topics by Age and Sex

At all median ages and for both sexes the children are interested in quantity, overall measurement, height, and speed. For the other topics there is a beginning and ending age. There appears to be no set pattern or consistency as to age or sex. Up to the eight-year-age level for both sexes the interest of children is not very broad. From the eight-year-age level through the fourteenth year for both sexes the mathematical interests of children are varied and diversified with all children being interested in the topics mentioned.

To provide a systematic picture of the beginning and ending age levels for interests in specific topics, not already mentioned in the above paragraph, the following is offered:

Topics and Age Limits

A) Width—from age nine of both sexes to age fourteen or girls grades IV–VIII and boys grades IV, V.

B) Distance—boys ages 7–14 and girls ages 9–13 or boys grades II–VIII and girls grades IV–VIII.

C) Volume (liquid)—boys ages 7–14 and girls ages 8–14 or boys grades I–VIII and girls grades II–VIII.

D) Thickness—boys ages 8–11 and 13 and girls ages 9, 12 or boys grades III, IV, V, VIII and girls grades III, VII.

E) Area—boys ages 8–13 and girls ages 11–13 or boys grades III–VIII and girls grades VI–VIII.

F) Circumference—boys age 12 in the seventh grade.

G) Temperature—girls age 10 and 12 in grades IV and VII.

H) Length—boys ages 6–14 and girls ages 8–14 or boys grades I–VIII and girls grades III–VIII.

I) Weight—boys ages 6–14 and girls ages 7–14 or boys grades I–VIII girls grades II–VIII.

J) Time—boys ages 7–14 and girls ages 6–14 or boys grades II–VIII and girls grades I–VIII.

The trends sufficiently clear cut to serve as a guide in grade placement for all grade levels in this study appears to be: (1) number, size, time, and money, (2) quantity, length, weight, overall measurement, height (altitude), volume, speed, and time as subtopics of number one.

The trends sufficiently clear cut to serve as guides to grade placement from grade III through VIII in the subtopics under number, size, time, and money appear to be quantity, height, overall measurement, weight, speed, time, width, distance, volume (liquid), thickness, and area.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

It will be recalled that the purpose of this study was to explore certain aspects of children's interests as clues to grade placement of arithmetic topics. The problem may be further elaborated in these questions:

What is the relation of children's interest to the patterns of curricula or school organizations?

To what extent is aviation material incorporated in published arithmetic texts?

What light can be thrown on the problem of grade placement in arithmetic by the questions asked about aviation topics by school children in grades I through VIII?

Relation of Children's Interest to the Pattern of School Curricula or School Organization

From the findings summarized, the answer to these questions, as far as they have been revealed, may be presented.

First, as to the relationship of children's interest to a curriculum pattern: The children are interested in the sociological aspects of arithmetic. They need a type of curriculum or school organization that will best incorporate such material. As outlined in the summary, in general, children were interested in the development of the concepts of such topics as quantity, measurement, speed, time, money, etc. The interest in these topics was quite consistent in all grade levels regardless of sex or age of individual pupils. The problem of the moment is whether the interest in these topics can best be used in the traditional, the activity, or the integrative curriculum. While the data from this study do not justify a clearcut decision, it does appear that the curricula conditions under which children experience activities conducive to the development of mathematical concepts are not dependent so much upon the curriculum pattern as upon the individual teacher. If the teacher is desirous of utilizing the interests of children in the development of mathematical concepts the choice of a curriculum pattern seems quite unimportant. However, the integrative curriculum with its emphasis on the importance of interest, holds the most promise.

Aviation Material in Recent Published Arithmetic Textbooks in Relation to Children's Interest

A survey of recent arithmetic textbooks reveals the extent to which aviation material has been incorporated in published texts.

For the most part the aviation material has been used in an incidental manner. The writers of arithmetic textbooks apparently have not realized the extent of knowledge and interest that children possess in aviation which this study so clearly indicates. In formulating problems the writers of arithmetic textbooks have been quite general. Very few specific facts about aviation have been given. Usually the problems begin with such phrases as 'an airplane' rather than giving the specific name of an airplane followed by accurate information. According to the present study children are seeking answers to specific questions on many kinds of airplanes dealing with specifications and performance. Within these questions a readiness to grasp arithmetical concepts is quite evident.

There is a need to change the treatment of arithmetic material in textbooks to include more accurate and specific facts about

aviation as well as other types of human endeavor. With the addition of more accurate, sociological material of the type in which children are interested, there would follow a greater interest in arithmetic that would aid materially in the attainment of quantitative number concepts and relationships.

This change in the future arithmetic textbooks presupposes that an effort will be made to find out what arithmetic concepts are inherent in communication, production and consumption of goods and services, recreation, health, and so on until all the basic social functions are completely surveyed. Then by capitalizing on the interest of children in these various fields, writers should construct an arithmetic program that will add meaning and understanding to the arithmetic concepts which the children so clearly show they are ready to grasp.

A source of accurate information usable by textbook writers and curriculum workers has been provided by Stanford School of Education as a project for the Civil Aeronautics Administration.

The present study reveals an available background of interest throughout the elementary school, differing in intensity at various levels, in the major concepts of arithmetic as they apply to aviation. These were presented in detail in the previous discussion, and will be incorporated in the recommendations to follow.

PROBLEM OF GRADE PLACEMENT

What light can be thrown on the problem of grade placement in arithmetic by the questions asked about aviation topics by school children in grades I through VIII?

The conclusions on grade placement as indicated by this study may be summarized as follows:

1) The children in grade I through VIII are definitely interested in quantity as expressed in number meaning and relationship.

a) This indicates a need for a revision of present arithmetic text to include more factual material.

b) Reading and writing of numbers has a more definite place on each grade level.

c) A broader quantitative meaning to numbers in the primary grades on a concrete basis concerning the activities of everyday living is sought by these lower grade children.

d) This reaching out for understanding and information is not

confined to the primary level. All grade levels are seeking an answer to how many.

2) Children in the primary through upper grade levels are interested in measurement.

a) Linear measurement of a more exact nature holds the greater interest for all children surveyed in this study. (1) Height (altitude) predominates over all other forms of measurement in all grades. (2) Of lesser importance than height, children of all grade levels are interested in length, width, thickness, overall measurement and distance.

b) Second to linear measurement in importance to all children is a desire for a better understanding and factual knowledge of speed and time relationship. (1) In the primary grades this implies that a more conscious effort on the part of teachers is needed to build beginning concepts in this direction. (2) In the intermediate and upper grades the speed and time relationship in addition to concepts reveal an implied interest in solving problems involving these relationships. In the upper grades part of the interest in time is of a vocational nature, that is the training period necessary for aviation personnel.

c) A third major phase of interest in measurement is a desire on the part of all children to attain a more complete concept of weight.

d) A fourth major interest as shown by this study is the interest of all children in liquid measurement. (Volume.)

e) Of lesser interest to children than linear measurement, speed, time, weight, and volume is that of area, direction, and temperature. (1) Interest in area becomes important at the sixth grade level although it appears for the first time in the third grade and each level thereafter. It would seem, therefore, that there may be some advantage in teaching area before the sixth grade on a conceptual base stressing meaning and application. (2) Since direction was mentioned once by a third- and a sixth-grade child, twice by seventh-grade children, and three times by eighth-grade children, the concept of cardinal directions are of little interest to children. (3) The importance of temperature and its relation to aviation is not significant to the children in this study. This fact reveals a rather narrow application of temperature in past arithmetic teaching as well as correlation with other subject-matter.

3) Money, as revealed in this study, is of importance to primary- and intermediate-grade children in connection with aviation. In the upper grades the cost of airplanes, and the vocational and avocational interest is paramount.

The following items are of interest but have no direct implications to grade placement:

(1) Children in grades I through VIII do not have a well defined interest in temperature.

(2) There is a need to give training to children in spacial discrimination through improved visual space perception.

(3) There is some evidence that learning a special subject (arithmetic) may be attained most efficiently with reference to some broader interest (aviation).

(4) There is evidence that there is not a single school grade at which a topic must be taught, but there are several at which it may be taught.

ON INTEREST IN GENERAL

The following items on mathematical interest indicated by the type of questions asked by children are offered as a by-product of the study:

1) The mathematical interest questions of these children do not seem to be the products of maturity; they are not the result of scholastic classification by grade levels; they are not regulated by sex, as a rule. In truth—it is probable that the children's mathematical interests are an outgrowth of the environment in which they live.

2) In areas where they have no experience, pupils cannot ask questions, except of the vaguest sort.

3) The children's interests in mathematical topics may be intensified because of military secrecy regarding airplane performance and construction.

4) The more experience and knowledge a child has of aviation the more specific are his mathematical interests.

5) The mathematical interest expressed by these children appears to be accentuated by the media (aviation) which is an integral part of human activity.

6) The mathematical interest expressed by these children gave evidence through grade I to VIII as being stable, consistent, reliable.

7) Due to the intense interest in aviation it appears that learning in mathematics may take place at levels below those which are customary.

8) The mathematical interests of children in grades I through VIII for curriculum selection should be explored in other areas of human endeavor besides aviation.

9) Subject-matter materials should be related primarily to the individual in his immediate environment.

BOOK REVIEWS

H. Carl Witherington, *Educational Psychology*. Boston: Ginn and Company, 1946, pp. 464.

This book covers the generally recognized fields of educational psychology. It treats mechanisms of heredity, reflexes, instinct, feeling and emotion, growth, the nature and measurement of intelligence, learning, acquiring educational tools and techniques —elementary (reading, spelling, etc.) and the higher rational— "learning to deal with the physical" and "the social world," appreciation, educational measurement, mental health, transfer, development of personality and character, and adult education. The introductory chapter includes a helpful section on techniques of effective study.

Chapter and topic headings are well chosen and serve to give a favorable first impression. The content is in the main conventional. The organization is interesting and the style is clear and direct.

Despite the fact that there is a minimum of technical language, some readers may feel that too much space is devoted to defining terms and explaining what is meant by habit, skill, learning, and other commonplace terms, especially since they are subsequently treated in a common sense way. Relatively little experimental work or factual material is cited. Illustrations tend to be hypothetical ones drawn from life situations. In an introductory text this may be a positive virtue; but it does not give much support to the introductory statement that educational psychology is "a science in its own right." It may tend to give the impression that educational psychology is an armchair discipline.

The book appears to treat most competently the measurement of intelligence and 'evaluating achievement.' The latter is in the Ralph W. Tyler tradition. The area of learning—theoretical and applied—is least adequate. The three pages on retention and forgetting are excellent, and could well have been expanded. The chapter on transfer is also quite good. It represents a sort of union of Gestalt theory and Judd's theory of generalized experience. Here is ventured something of a critical treatment. A chapter devoted to oral language, spelling, arithmetic, reading, handwriting, and foreign languages follows the pattern set by Judd. The material of this chapter is good, though necessarily

condensed, since it is compressed into a single chapter of about thirty pages.

At times a religious and moral tone of the book becomes quite evident. "Fellowship with the Supreme Being" and "contact with the Divine" will have a special appeal for some students and teachers.

There is a current of Gestalt psychology running through the book, which becomes stronger toward the end. This is not particularly evident in the fore part, although there is a depreciation of 'bond psychology' and affirmations that learning proceeds from whole to part.

Students of H. C. Morrison will detect the influence of that worthy upon the author's thinking.

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Glenn M. Blair. *Diagnostic and Remedial Teaching in Secondary Schools.* New York: The Macmillan Co., 1946, pp. 422.

Too frequently students in secondary schools are severely retarded in the basic tools of learning. Although this is true particularly of reading, pupils are frequently deficient in other areas. Although the need for setting up remedial programs has become urgent, most high-school teachers are not trained to teach children to read. The organization of adequate programs, therefore, places added responsibilities upon teachers and administrators. This book is intended "to supply teachers, principals, supervisors, and superintendents with concrete and practical suggestions for carrying out remedial programs in their schools" as well as for a textbook in teacher-training institutions.

The major portion of the book is devoted to diagnostic and remedial teaching of reading. Lesser space is devoted to remedial teaching of arithmetic, spelling, handwriting, and fundamentals of English. After emphasizing the importance of reading in secondary-school work, the author outlines techniques for locating poor readers, discusses causes of reading deficiency, outlines remedial treatment, cites examples of remedial reading programs, and lists materials and practice exercises. Similar but less pretentious discussions are given for arithmetic and the other areas.

Contributions which deserve special commendation include the

following: (1) The material is well organized, concise, and clearly written. (2) Diagnostic and remedial procedures appear practical and adequate. (3) The description of remedial programs in operation should be helpful to school administrators. (4) The description of materials is extensive and very useful. (5) Bibliographical references are extensive and well selected. (6) In general, the author is critical of source materials. (7) The view that any competent teacher with proper attitudes toward pupils can make some contribution to remedial teaching is well taken. For "remedial teaching is just good teaching." (8) The recognition that 'Big Little Books' and comics make useful reading material for certain retarded pupils is to be commended. If the pupil will only read something, there will be not only improvement in reading skills, but a chance to progress to other types of literature.

The critical reader, however, will note certain limitations of the book: (1) The author fails to stress sufficiently the need for measurement of both near- and far-vision in determining the status of visual perception. There is little relationship between the two. (2) Although the author is to be commended for his view that eye-movement habits are symptoms rather than causes of reading disability, he apparently fails to note the limitations of ophthalmograph film records in the clinical situation. The reliability of eye-movement records for reading one hundred words (as used here) are so unreliable that they lack validity in the clinical situation. (3) It is true, of course, that good teachers can make useful case studies. Nevertheless, there are limitations not stressed by the author in describing how to make a case study. For instance, the instructions for conducting an interview might well be more complete rather than referring the teacher to a book which probably is not available. Furthermore, there is not sufficient stress placed upon the desirability of referring certain cases to a specialist in counseling. (4) The statement, "A school which purports to be carrying on an adequate reading program should have available for student use thousands of books dealing with a tremendous range of subjects and of all levels of difficulty" may appear discouraging to some of the smaller schools.

In general, this is an excellent book. It should do much to promote more adequate remedial teaching in the secondary schools.

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HERMAN F. BRANDT. *The Psychology of Seeing.* New York: The Philosophical Library, 1945, pp. 240, $3.75.

In *The Psychology of Seeing* Brandt has summarized and interpreted a large body of data resulting from investigations conducted over a period of years in the Visual Research Laboratories at Drake University. The organization of the book is designed to serve four practical ends:

1) Call attention to ocular photography as scientific approach to the study of human behavior.

2) Add new information to the already known principles of the psychology of seeing.

3) Make available to educators, artists, advertisers, oculists, lighting engineers, and vocational counselors such findings as may be applicable to their respective fields.

4) Provide an inspiration to all those pursuing the studies of ocular performance and their psychological implications. (p. iii)

Brandt's point of view in approaching the subject of ocular photography is that a functional relationship exists between eye movements and central processes; the latter activities, plus the environment of the individual, constituting the determiners for the variation of location, frequency, sequence, and duration of fixations of eye movements and of distance and direction of excursions. Hence, ocular patterns, as recorded by a camera, form a record of performance in any given task, indicating the observer's sensory and motor experiences.

In Chapter II the specially constructed monofilm bidimensional camera is described in detail and these advantages enumerated: (1) eye movements in every direction are recorded—as well as the horizontal movement to which previous cameras were limited; (2) extreme portability; (3) low operating cost due to one film being used instead of the former two; and (4) easy projection and analysis of the film record, since only a dot is recorded on the film for each fixation.

Chapter III deals with basic eye-movement laws and tendencies and reports material dealing with fixations and excursions that is already familiar to most psychologists. The author contends that left and top positions are preferred in human eye movements, which he attributes to psychological and physiological causes. Because he finds that the human eye tends to make only four fixations in one direction at any one time, Brandt

argues that lines of print that are unusually long as well as those that are unusually short are to be avoided. As has been reported elsewhere, Brandt finds that there is a definite preference for horizontal, as opposed to vertical movements of the eye.

Chapter IV concerns itself extensively with the relationship of the findings of ocular photography to the advertising media. Through the use of flash preference tests and other methods, Brandt arrived at certain conclusions with respect to the attention value of various advertisements, in terms of size, mechanical and psychological observational incentives, isolation, color, implied motion, arrangement, and sex preferences.

In the last half of the book, findings with respect to advertising and other data are related to educational, artistic, aesthetic, and psychological problems. The volume closes with a short chapter devoted to projected studies. Very few references are made to research studies of other scientists working in the same or allied fields.

The Psychology of Seeing deals lucidly with a technical subject. Enough background is given in each chapter to enable the reader to understand the findings. It is a volume that will not only be useful to the professional psychologist, but also to others interested in a wide range of 'eye-related' occupations and endeavors. The illustrations are numerous and helpful.

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